

# PATENT SPECIFICATION

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## (54) A PROCESS FOR THE PREPARATION OF MOULDS AND CORES

(71) We, SHELL INTER-  
 NATIONALE RESEARCH MAAT-  
 SCHAAP B.V., a company organised under  
 the laws of The Netherlands, of 30 Carel  
 van Bylandtlaan, The Hague, The Nether-  
 lands, do hereby declare the invention, for  
 which we pray that a patent may be granted  
 to us, and the method by which it is to be  
 performed, to be particularly described in and  
 by the following statement:—

The present invention relates to a process  
 for the preparation of a mould or core.

When casting metal, in particular iron and  
 steel, use is often made of moulds or cores  
 mainly consisting of sand in order to be  
 able to produce a casting of the desired shape  
 and model.

To obtain moulds and cores having suffi-  
 cient strength it is customary to add a binder,  
 in particular an organic resin, to the sand and  
 to allow this binder to harden under the  
 influence of heat and/or with the aid of a  
 catalyst. A mould or core prepared in this  
 way cannot generally be used as such because  
 liquid metal (for example iron) may pene-  
 trate the sand during casting to form fins,  
 while in addition sand may react to form  
 silicates which adhere to the fins and con-  
 sequently to the casting (vitrification glazing)  
 so that the casting does not obtain the desired  
 shape. Fin formation and vitrification glazing  
 occur in particular at sharply curved surfaces  
 such as corners.

The fins and vitrification glazed material  
 must in most cases be removed with the aid  
 of mechanical means, for example by grinding  
 or cutting, which is a time-consuming opera-  
 tion and is not attractive from a practical and  
 economic point of view.

The resultant moulds and cores do not  
 normally have a smooth surface as a result  
 of the texture of the sand grains on the sur-  
 face. In order to obtain a casting having a  
 smooth surface it is normal practice to pro-  
 vide the moulds and/or cores with a coating.  
 This coating mostly consists of materials

such as powdered zirconia, ceramic materials,  
 coal dust powdered coke, powdered graphite,  
 or mixtures thereof. Application of the coat-  
 ing is generally effected by treating the mould  
 or core which is obtained after hardening  
 of the organic binder with a, for example,  
 aqueous or alcoholic (such as isopropanolic)  
 suspension or solution of the coating material,  
 with subsequent removal of the volatile com-  
 ponents (e.g. water or isopropyl alcohol)  
 from the surface of the mould by evaporation  
 or burning.

Although the application of a coating pro-  
 vides a certain degree of protection against  
 fin formation and vitrification glazing the  
 coating may be penetrated (and fin formation  
 may occur) if the moulds are subjected to a  
 high thermal loading during casting, viz. when  
 as a result of the shape or size of the mould  
 or the core the heat is difficult to remove or  
 cannot be sufficiently removed during cast-  
 ing. This will occur particularly with rela-  
 tively thick layers of metal and/or with rela-  
 tively small cores having a large surface area  
 but a small volume. At present no process is  
 known to prevent fin formation and vitrifica-  
 tion glazing at high thermal loading of moulds  
 and cores.

The invention provides a process for the  
 preparation of moulds and cores in which fin  
 formation and vitrification glazing can be  
 eliminated or at least substantially reduced  
 even at high thermal loading.

According to the present invention a pro-  
 cess for the preparation of a mould or core,  
 comprises hardening a shaped mixture (as  
 herein defined) containing sand, an organic  
 binder and powdered precipitation bitumen.

The term "mould" as used hereinafter  
 also includes a core.

A shaped mixture is defined herein as a  
 mixture formed into such a shape that a  
 mould having the desired dimensions and  
 shape is obtained after hardening. To this  
 end it is very suitable to allow the mixture

to harden in a core box or on a pattern having the desired shape.

5 Preferably 95—99.5% by weight of the mixture to be hardened consists of sand. Although many types of sand are suitable, such as chromite sand, zirconia sand, olivine sand, for economic and practical reasons quartz sand is preferably used.

10 By "organic binder" is meant organic compounds which can be made to react to form high-molecular compounds which generally have a complex three-dimensional structure. These compounds impart such a stability to the sand that it retains the shape it has after the said reaction, so that the mould does not disintegrate after the core box or pattern is removed. In the present application this reaction is defined as hardening.

20 The quantity of the organic binder very suitably amounts to 0.1—5% by weight of the mixture to be hardened.

25 Examples of suitable organic binders are furfuryl alcohol-urea-formaldehyde resins, furfuryl alcohol-phenol-formaldehyde resins, epoxy resins; furfuryl alcohol-urea-formaldehyde resins are preferred.

30 Amounts of furfuryl alcohol incorporated in the resin of 50—95% by weight, based on the amount of the resin in question, for example furfuryl alcohol-urea-formaldehyde resin, are very suitable.

35 In order to improve the bonding of the resin to the sand so that the amount of resin required is reduced, a silane is mostly added to the mixture to be hardened, preferably in an amount of 0.05—0.5% by weight, based on the resin.

40 Although the amount of powdered precipitation bitumen may vary within wide limits, it is preferred to use an amount of 0.5—10% by weight, based on the mixture to be hardened. When the amounts are too small, there is the risk of local fin formation and vitrification glazing when the casting is cast.

45 The use of very large amounts of powdered precipitation bitumen does not yield any technical advantages.

50 Precipitation bitumens are obtained by treating a residual fraction with a precipitation agent, suitable precipitation agents being aliphatic hydrocarbons (for example those having at most 6 carbon atoms). Preference is given to propane bitumen which is obtained by precipitation from a residual fraction with the aid of propane. The said precipitation bitumens can be used as such or (as blown bitumens) after treatment at elevated temperature with an oxidation agent, for example air.

60 The powdered bitumen can be obtained from precipitation bitumen or blown precipitation bitumen in any suitable manner. As examples may be mentioned grinding such a solid bitumen and spraying the bitumen in the liquid phase. Powdered bitumen of which

the grains have a cross-section of not greater than 1 mm, e.g. 0.02—1.0 mm, are very suitable.

Hardening may be effected by heating, but this requires the supply of heat, while there is also a risk that the powdered bitumen may melt and that the molten bitumen may run. Hardening is therefore preferably effected at approximately room temperature with the aid of an acid, such as p-toluene sulphonic acid. Phosphoric acid is preferred. The amount of acid is preferably 20—100% by weight, based on the organic binder; the hardening rate is dependent on the ambient temperature and the pH of the sand as well as on the amount of acid. The acids to be used as catalyst may contain water; phosphoric acid containing 20—30% of water is excellent for use.

When it is envisaged to carry out the process according to the invention to obtain moulds in which castings having a smooth surface can be produced, these moulds are very suitably provided with a coating.

The way in which this coating is applied and the composition thereof do not differ from the known coating of moulds prepared in a different manner than by hardening a shaped mixture containing sand, organic binder and powdered precipitation bitumen.

For application of the coating, the mould is very suitably treated with a suspension in an alcohol (such as isopropyl alcohol) or water of a material suitable as coating, such as powdered zirconia, ceramic materials, coal dust, powdered coke, powdered graphite, or mixtures thereof. In addition, the suspensions mostly contain a binder, such as starch or products prepared therefrom, and a suspension agent, such as clays or oxides of metals.

The alcoholic or aqueous suspension may be applied to the moulds in various ways, for example by spraying, pouring, brushing or by immersing the mould in the suspension. The volatile solvent, viz. alcohol or water, is subsequently removed by evaporation, drying, or (if possible burning). It is also possible to heat the mould before it is immersed in the suspension; the volatile solvent evaporates after immersion. If the latter technique for applying the coating is used, care must be taken that the temperature of the mould remains below the softening point of the bitumen present in the powdered precipitation bitumen, since otherwise there is the risk of the powder form of the bitumen being lost.

The invention also includes a process for the casting of metal, in particular iron and steel, using a mould prepared in accordance with the process of the invention, and to the castings thus obtained.

#### EXAMPLE

A number of moulds was prepared as follows:

Sand, powdered precipitation bitumen and

catalyst were mixed in a vane mixer for one minute. Furfuryl alcohol-urea-formaldehyde resin was subsequently added and mixing continued for one minute. The temperature during mixing was 22—25°C, the relative humidity 60—70%. The sand used had an AFS fineness of 59, the bitumen was a propane bitumen and the powdered grains had a diameter of less than 0.7 mm and an average diameter of approx. 0.25 mm. The quantities of powdered bitumen were varied. The furfuryl alcohol-urea-formaldehyde resin was prepared from 85% by weight of furfuryl alcohol and 15% by weight of urea-formaldehyde resin, contained approx. 0.2% by weight of silane, and was added in an amount of 1.4% by weight, based on the amount of sand. The catalyst used was 75% phosphoric acid which was added in an amount of 50%, by weight, based on the amount of furfuryl alcohol-urea-formaldehyde resin.

The resultant mixture was transferred from the vane mixer to a wooden core box and

had hardened after approx. 45 minutes. A number of the resultant moulds were provided with a coating by immersion in a suspension of graphite and powdered coke in isopropyl alcohol, followed by burning of the isopropyl alcohol adhering to the mould.

In the moulds castings were produced by casting grey cast iron 25 into the moulds at a temperature of approx. 1380°C and by subsequently removing the mould after cooling. To determine the quality of the resultant castings attention was paid to fin formation and roughness of the surface. The Table shows the results in dependence on the amount of powdered precipitation bitumen present. It can be clearly seen that by adding powdered precipitation bitumen fin formation is counteracted and when 2.6% by weight of the powdered bitumen is added, it is even completely prevented. Without coating a rough surface is obtained which is, however, admissible for many applications.

TABLE

Test No.	weight percentage of powdered bitumen (based on sand)	Coated	Fin formation	Texture of the surface
1	0	yes	very many	—
2	1	yes	many	—
3	2	yes	few	—
4	2.6	yes	none	smooth
5	2.6	no	none	rough

The tensile strength of the mould used in test 4 was measured with a "Festigkeitsprüfapparat", type SPDR, with "Biegevorrichtung" GM-527, sold by Georg Fischer AG, Schaffhausen. The tensile strength was found to be 19 kg after 48 hours, which is quite sufficient for the usual applications.

#### WHAT WE CLAIM IS:—

1. A process for the preparation of a mould or core, which comprises hardening a shaped mixture (as herein defined) containing sand, an organic binder and powdered precipitation bitumen.

2. A process as claimed in Claim 1, wherein 95—99.5%, by weight, of the mixture to be hardened consists of sand.

3. A process as claimed in Claim 1 or Claim 2, wherein the sand is quartz sand.

4. A process as claimed in any one of the preceding Claims, wherein 0.1—5%, by weight, of the mixture to be hardened consists of organic binder.

5. A process as claimed in any one of the preceding Claims, wherein the organic binder is a furfuryl alcohol-urea-formaldehyde resin.

6. A process as claimed in Claim 5, wherein the amount of furfuryl alcohol incorporated in the resin is 50—95%, by weight, based on the total resin.

7. A process as claimed in any one of the

preceding Claims, wherein a silane is added to the mixture to be hardened.

8. A process as claimed in Claim 7, wherein the amount of silane is 0.05—0.5% by weight, based on the organic binder.

9. A process as claimed in any one of the preceding Claims, wherein 0.5—10%, by weight, of the mixture to be hardened consists of powdered precipitation bitumen.

10. A process as claimed in any one of the preceding Claims, wherein the precipitation bitumen is a blown bitumen.

11. A process as claimed in any one of the preceding Claims, wherein the precipitation bitumen used is a propane bitumen.

12. A process as claimed in any one of the preceding Claims, wherein the cross section of the grains of powdered precipitation bitumen is less than 1 mm.

13. A process as claimed in any one of the preceding Claims, wherein hardening is effected with the aid of an acid.

14. A process as claimed in Claim 13, wherein the acid is phosphoric acid.

15. A process as claimed in Claim 13 or Claim 14, wherein the quantity of acid is 20—100%, by weight, of the organic binder.

16. A mould or core prepared by means of a process according to any one of the preceding Claims.

17. A process for the preparation of a

- mould or core in which castings having a smooth surface can be produced, which comprises providing a mould or core as claimed in Claim 16, with a coating. 15
- 5 18. A process as claimed in Claim 17, wherein the coating is provided by treating the mould or core with a suspension in an alcohol or in water of a coating material followed by removal of the alcohol or water.
- 10 19. A mould or core obtained by a process as claimed in Claim 17 or 18.
20. A process for the manufacture of a metal casting, which comprises casting a molten metal in a mould as claimed in Claim 16 or Claim 19 or in a mould comprising a core as claimed in Claim 16 or Claim 19. 15
21. A casting obtained by the process as claimed in Claim 20.
22. A process as claimed in Claim 1 and substantially as hereinbefore described, with particular reference to the Example. 20

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